TECHNICAL REPORT 9210

BIOLOGICAL TREATMENT OF COMPOSITION B WASTEWATERS

III. ANALYSIS OF PERFORMANCE OF HOLSTON ARMY AMMUNITION PLANT WASTEWATER TREATMENT FACILITY, JANUARY 1985 THROUGH AUGUST 1986: ERRATA

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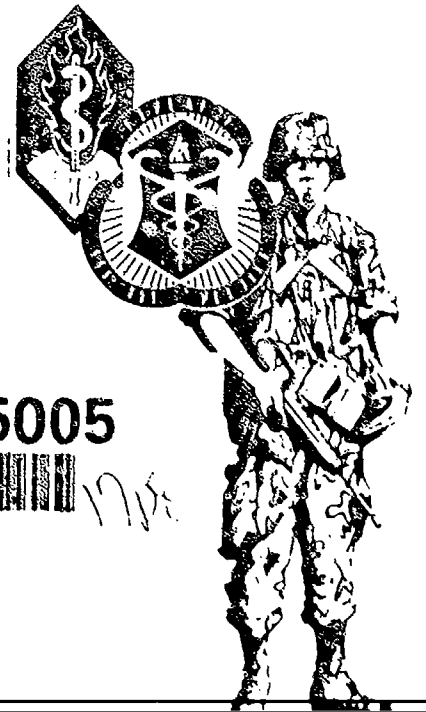

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Effluent biochemical oxygen demand (BOD) levels at the Holston Army Ammunition Plant wastewater treatment facility, as quoted in U.S. Army Biomedical Research and Development Laboratory Technical Report 8806, are in error. This report corrects those values, as well as the derived rate coefficients for BOD destruction. Conclusions from the earlier report are unchanged.

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PREFACE

This study has been performed under R&D Project No. 1L162720D048, U.S. Army Toxic and Hazardous Materials Agency, and is part of the Army Materiel Command Pollution Abatement and Environmental Control Technology Program. Project Officer was Janet Mahannah. The authors gratefully acknowledge the assistance of Mrs. Bonnie Smith, Holston Defense Corporation, in preparing this report.

INTRODUCTION

In early 1985, the U.S. Army Biomedical Research and Development Laboratory (BRDL, at that time the U.S. Army Medical Bioengineering Research and Development Laboratory) undertook an evaluation of performance of the major unit processes of the Holston Army Ammunition Plant (HSAAP) wastewater treatment facility.[1] It has subsequently been learned that HSAAP reported net rather than gross values of effluent biochemical oxygen demand (BOD), i.e. the BOD of the effluent less the BOD at the Holston River intake for the same day. Thus, derived BOD removal rate coefficients (k_{BOD}) presented in Table 7 of the earlier report are too high (ca. two-fold). The present report provides corrected values for BOD and k_{BOD}.

SAMPLING AND ANALYSIS

Influent chemical oxygen demand (COD) and volatile solids (biomass) values were determined each shift from grab samples analyzed at the laboratory of the HSAAP wastewater treatment plant. Effluent five-day BOD samples, analyzed in the Development and Control Department, represent 24-hr composites[2] (Appendix Table A1). Analyses were performed according to Standard Methods.[2] Aeration basin detention times were calculated from effluent flow rates recorded continuously at the wastewater treatment plant. Monthly average data are presented in Table 1.

RESULTS AND DISCUSSION

During the study period, four completely mixed basins provided a total volume of 1.5 million gallons of wastewater under aeration (Figure 1); these are treated in the original and present reports as a single completely mixed basin. Operational and performance parameters are provided in Table 1.

The organic removal rate coefficient, k_{BOD}, is calculated from the equation:[3]

$$[S_o(S_o - S_e)]/X_v t = k_{BOD} S_e$$

where S_o = influent total BOD_5
S_e = effluent soluble BOD_5
X_v = volatile suspended solids

Lacking influent BOD data for the aeration basins, we have assumed, as before, that $S_o = (COD_{infl} - COD_{effl}) + S_e$; this may slightly underestimate S_o, but should be sufficiently accurate for calculation of k_{BOD}. Effluent BOD levels are uniformly low, which is to be expected if, as noted earlier, principal organic waste constituents from RDX production wastewaters are formaldehyde and formic acid, with lesser amounts of cyclohexanone, acetone, and acetic acid, *inter alia*. All these compounds are highly biodegradable, and in the case of formaldehyde chemical degradation through air oxidation is likely. Temperature effects on k_{BOD} are predictable, with late summer and autumn rates being nearly double late winter rates (Table 1 and Figure 2), corresponding to a difference of approximately 10^0.[1]

It is of interest to note that plant effluent BOD levels are only slightly higher than Holston River levels at the raw water intake (Appendix A1).

LITERATURE CITED

1. Burrows, W.D., E.T. Paulson and R.P. Carnahan. 1988. Biological treatment of composition B wastewaters II. Analysis of performance of Holston Army Ammunition Plant wastewater treatment facility, January 1985 through August 1986. Technical Report 8806, AD A217636. Fort Detrick, Frederick, MD: U.S. Army Biomedical Research and Development Laboratory.

2. American Public Health Association. 1980. Standard Methods for the Examination of Water and Wastewater 15th Ed. Washington, DC.

3. Adams, C.E., Jr, and W.W. Eckenfelder, Jr, editors. 1974. Process Design Techniques for Industrial Waste Treatment. Nashville, TN: Enviro Press, Inc., p53ff.

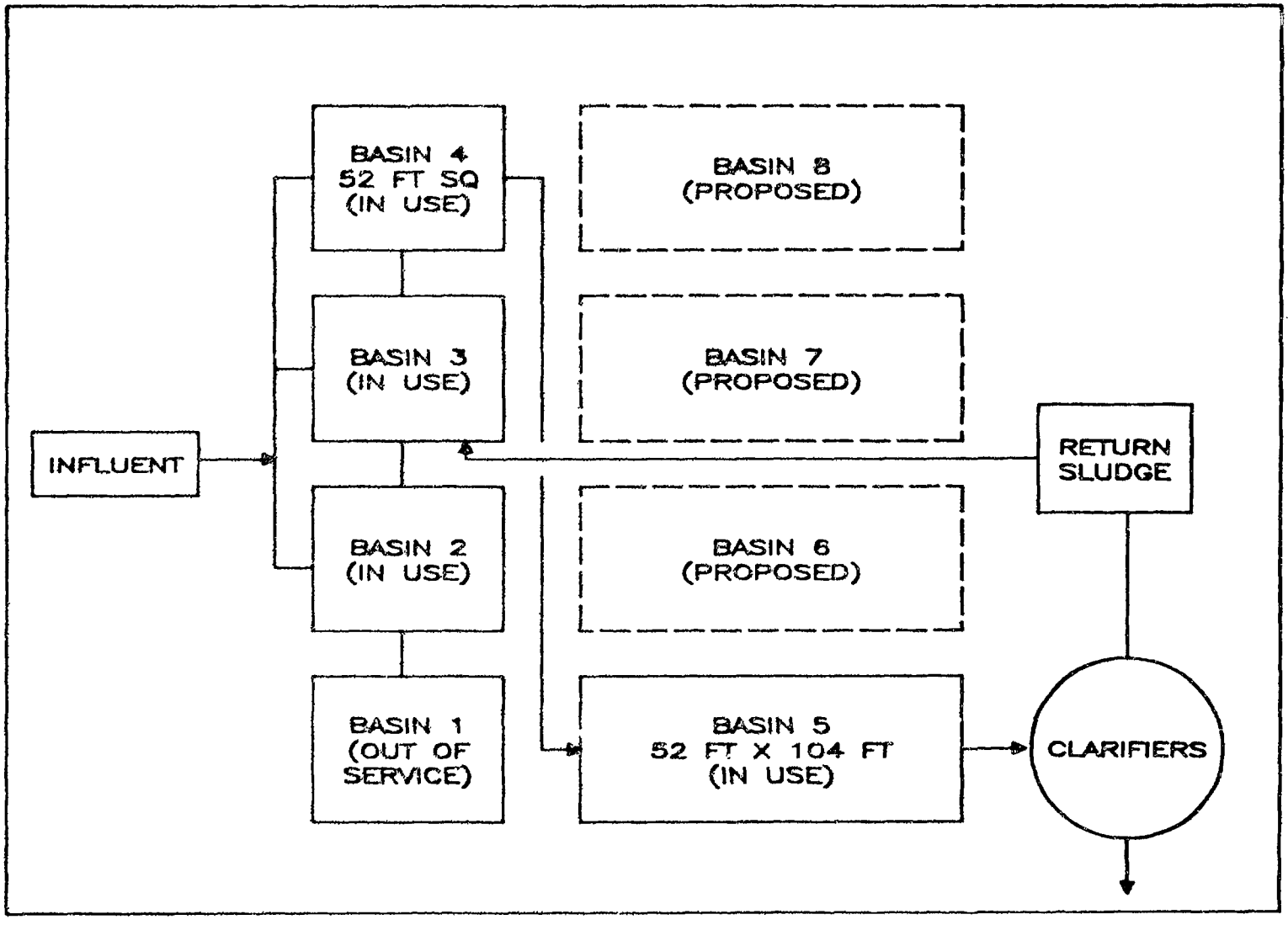

Figure 1. Schematic of Aeration Basins.

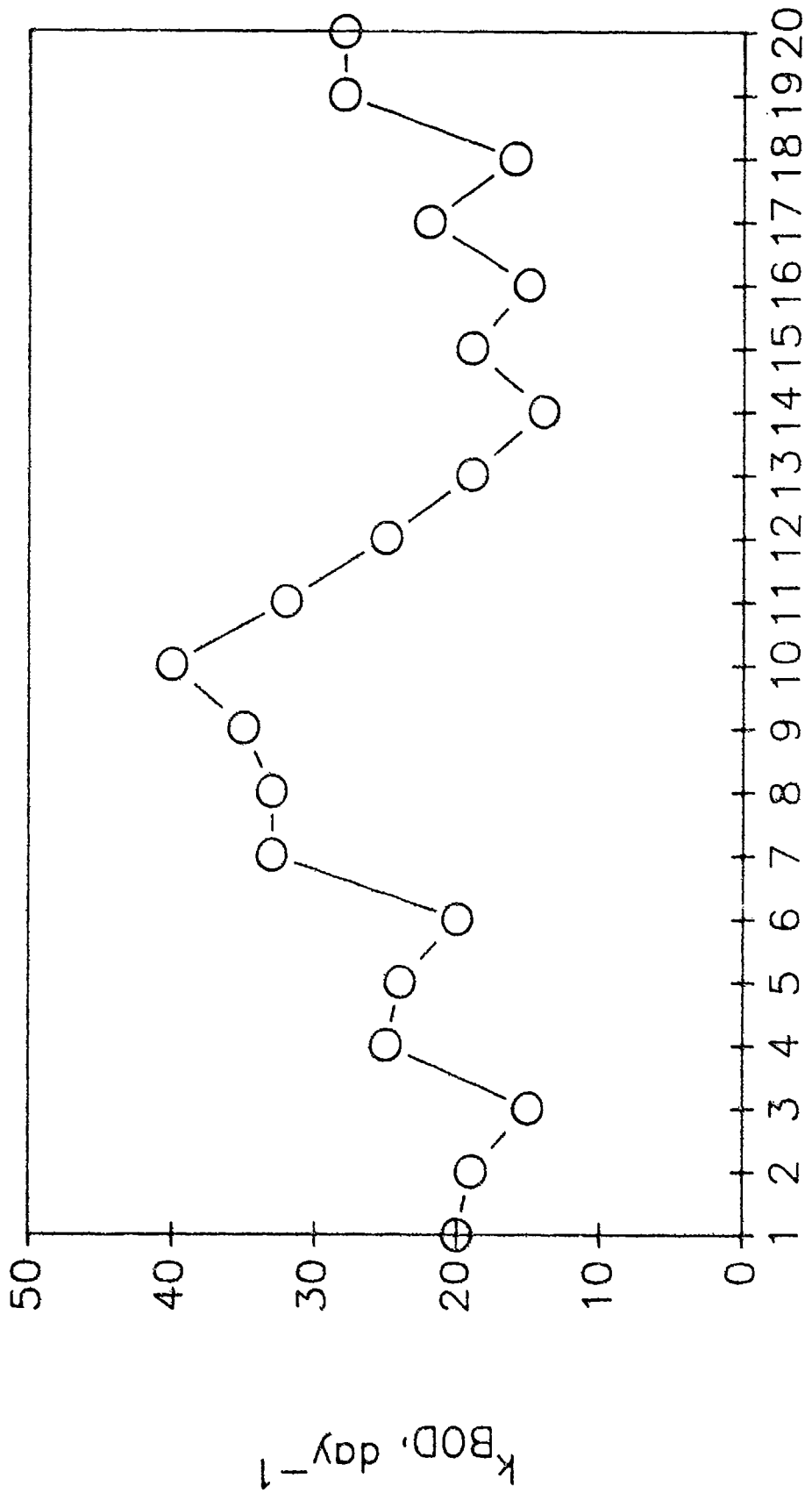

Figure 2. Rates of BOD Destruction, January 1985 through August 1986

TABLE 1. ACTIVATED SLUDGE PERFORMANCE, CORRECTED

Month	Infl COD	Effl COD[a]	X_v	t	S_e[b]	S_o	k_{BOD}	Temp.[c]
	mg/L	mg/L	mg/L	day	mg/L	mg/L	day^{-1}	
JAN 1985	210	25	1404	0.318	3.9	189	20	
FEB 1985	249	36	1643	0.292	5.2	218	19	
MAR 1985	215	30	1956	0.276	4.4	189	15	
APR 1985	203	21	1554	0.284	3.0	185	25	
MAY 1985	186	29	1115	0.286	3.3	160	24	
JUN 1985	190	28	1061	0.306	4.2	166	20	
JUL 1985	250	21	1613	0.322	3.1	232	33	
AUG 1985	213	20	1454	0.304	2.6	196	33	
SEP 1985	225	28	1274	0.316	2.8	200	35	
OCT 1985	235	25	1401	0.331	2.4	212	40	
NOV 1985	219	27	1239	0.299	3.2	195	32	
DEC 1985	261	38	1485	0.300	4.6	228	25	
JAN 1986	293	55	1580	0.331	6.0	244	19	13.5
FEB 1986	260	48	1499	0.298	7.3	219	14	15.1
MAR 1986	259	42	1622	0.321	5.0	222	19	16.2
APR 1986	192	33	1269	0.369	3.6	163	15	20.3
MAY 1986	164	27	1024	0.330	2.6	140	22	23.6
JUN 1986	141	29	884	0.303	3.0	115	16	24.9
JUL 1986	150	26	698	0.303	2.7	127	28	25.1
AUG 1986	145	22	824	0.289	2.3	125	28	25.3

a. Data taken from samples of plant effluent.
b. Data are for composited samples of plant effluent, taken from Discharge Monitoring Report.
c. Morning temperatures measured 3-5 times per week in the final aeration basin.

TABLE A1. BIOCHEMICAL OXYGEN DEMAND: HSAAP WASTEWATER TREATMENT PLANT EFFLUENT AND RIVER WATER[a]

Date	Jan 1985		Feb 1985		Mar 1985		Apr 1985		May 1985		Jun 1985	
	PE	RW	PE	RW	PE	RW	PE	RW	PE	RW	PE	RW
1			4	2	4	1	3	4	3	1	6	4
2			4	3	5	5	2	3	1	2	5	5
3			4	3	4	2	4	3	2	2	5	3
4			4	4	5	2	2	8	2	9	6	3
5			6	2	8	2	2	2	3	3	5	2
6			4	2	4	3	2	2	3	3	5	2
7			7	4	5	3	2	2	2	2	7	3
8			8	2	4	2	2	3	1	1	6	3
9			8	2	8	5	5	17	3	2	5	2
10			5	2	7	3	3	2	1	2	4	2
11			4	3	7	2	4	5	3	2	5	3
12	3	2	7	3	0	2	4	3	3	3	2	2
13	4	3	4	5	2	2	4	12	3	2	4	2
14	3	2	4	2	3	1	5	1	2	2	3	2
15	3	6	3	3	2	1	4	3	5	1	5	2
16	5	2	6	2	6	4	4	3	3	2	7	2
17	4	1	5	3	4	2	2	2	2	2	6	2
18	9	1	6	4	4	2	2	3	2	2	2	1
19	3	1	4	3	3	2	2	2	2	2	5	3
20	4	7	4	3	5	5	3	3	1	1	6	4
21	6	6	7	2	3	2	4	1	4	2	3	2
22	33[b]	23	6	2	6	5	3	3	8	3	3	5
23	2	1	7	2	6	4	4	3	2	1	2	3
24	2	1	6	3	5	3	2	2	5	3	2	1
25	3	1	5	3	5	2	2	1	4	3	3	2
26	8	12	6	2	6	2	2	3	5	3	4	1
27	2	17	4	2	2	2	3	2	6	2	2	3
28	3	13	5	1	3	2	3	2	6	2	3	6
29	1	1			3	2	3	3	9	2	2	4
30	5	7			4	2	3	2	4	1	3	2
31	4	5			3	2			3	2		
Av	3.9	5.9	5.1	2.6	4.4	2.5	3.0	3.5	3.3	2.3	4.2	2.7

a. PE = Plant Effluent, the total output from HSAAP wastewater treatment facility; RW = River Water or Raw Water, plant intake water before treatment.
b. Value not included in average.

TABLE A1, CONT. BIOCHEMICAL OXYGEN DEMAND: HSAAP WASTEWATER TREATMENT PLANT EFFLUENT AND RIVER WATER[a]

Date	Jul 1985		Aug 1985		Sep 1985		Oct 1985		Nov 1985		Dec 1985	
	PE	RW	PE	RW	PE	RW	PE	RW	PE	RW	PE	RW
1	2	2	2	2	2	2	3	2	1	1	3	3
2	3	2	4	2	2	1	3	1	2	2	4	2
3	4	1	3	2	1	1	2	1	2	2	3	2
4	4	2	3	2	1	1	2	1	1	2	4	5
5	3	9	3	1	1	1	2	2	1	2	3	1
6	2	2	3	2	4	1	2	2	2	2	4	2
7	2	1	1	1	2	2	2	2	3	3	2	2
8	3	2	2	1	1	1	3	1	2	1	2	2
9	6	2	2	1	4	1	1	1	4	5	2	2
10	3	1	2	2	2	2	3	2	5	5	3	1
11	3	1	2	1	2	1	3	1	5	5	4	7
12	5	2	1	2	3	1	3	3	8	9	3	1
13	5	4	1	2	2	1	4	3	2	1	3	7
14	5	2	3	1	1	1	2	2	1	1	5	1
15	1	1	2	1	1	1	2	1	1	1	5	2
16	3	3	2	1	1	1	2	1	2	4	7	1
17	3	2	2	2	4	4	2	1	2	2	7	1
18	5	1	10	2	4	1	2	2	13	2	8	3
19	4	4	2	2	4	1	2	3	1	2	4	1
20	2	1	4	3	4	2	2	2	3	2	4	1
21	2	1	2	1	6	2	3	4	2	2	7	2
22	4	1	3	1	3	1	3	2	4	1	6	2
23	4	3	2	1	3	3	3	3	5	4	6	2
24	2	1	2	3	8	3	2	4	7	3	8	2
25	2	1	4	1	3	1	3	3	3	3	8	3
26	2	1	2	3	5	1	2	3	4	3	9	2
27	4	1	2	2	3	1	2	2	1	0	3	2
28	2	2	2	2	4	3	2	2	2	2	4	3
29	2	2	2	1	3	2	3	5	3	2	4	2
30	2	3	2	1	4	2	1	2	3	2	4	3
31	3	1	2	2		2	1				4	2
Av	3.1	2.0	2.6	1.6	2.8	1.5	2.4	2.1	3.2	2.5	4.6	2.3

a. PE = Plant Effluent, the total output from HSAAP wastewater treatment facility; RW = River Water or Raw Water, plant intake water before treatment.

TABLE A1, CONT. BIOCHEMICAL OXYGEN DEMAND: HSAAP WASTEWATER TREATMENT PLANT EFFLUENT AND RIVER WATER[a]

Date	Jan 1986		Feb 1986		Mar 1986		Apr 1986		May 1986		Jun 1986	
	PE	RW	PE	RW	PE	RW	PE	RW	PE	RW	PE	RW
1	5	2	6	8	12	3	1	2	2	2	2	2
2	8	2	7	3	8	2	8	4	4	3	3	2
3	9	1	9	4	9	2	2	3	4	4	4	1
4	2	2	7	2	14	2	3	2	4	3	3	2
5	3	2	8	2	7	1	4	2	3	3	5	2
6	3	1	8	3	4	4	4	3	4	2	3	2
7	5	2	9	1	9	3	3	3	4	2	3	2
8	5	5	8	1	4	3	3	2	2	2	2	2
9	9	3	7	2	7	4	3	3	2	2	2	1
10	6	1	8	2	6	4	8	2	4	22	2	2
11	5	3	13	4	11	2	4	2	3	2	3	2
12	6	3	5	1	4	3	5	3	3	2	2	1
13	5	6	6	2	3	1	5	4	3	2	2	1
14	5	2	8	1	3	2	5	4	2	4	4	2
15	5	2	8	2	6	3	2	2	2	4	3	2
16	7	4	11	5	6	3	2	2	2	6	3	2
17	6	5	10	8	5	2	2	3	3	2	4	2
18	7	3	6	2	4	3	3	3	3	1	90	2
19	5	3	8	1	3	2	3	2	2	2	6	2
20	8	3	8	2	2	2	2	4	3	2	3	2
21	13	4	8	7	3	1	2	2	2	3	5	2
22	9	5	5	2	4	3	4	3	1	2	3	2
23	7	6	4	2	4	4	4	1	2	9	2	2
24	8	2	2	2	2	4	8	3	3	7	3	1
25	2	3	2	2	4	2	4	3	1	7	2	1
26	3	3	8	3	2	1	2	3	5	1	6	2
27	3	2	7	2	2	2	2	2	1	1	1	1
28	2	2	8	2	2	2	2	2	1	1	3	4
29	8	2			2	1	6	2	1	1	2	2
30	8	3			2	1	2	2	3	1	2	2
31	8	7			1	2			2	1		
Av	6.0	3.0	7.3	2.8	5.0	2.4	3.6	2.6	2.6	3.4	3.0[b]	1.8

a. PE = Plant Effluent, the total output from HSAAP wastewater treatment facility; RW = River Water or Raw Water, plant intake water before treatment.
b. 18 Jun 86 BOD value omitted from average.

TABLE A1, CONT. BIOCHEMICAL OXYGEN DEMAND: HSAAP WASTEWATER TREATMENT PLANT EFFLUENT AND RIVER WATER[a]

Date	Jul 1986		Aug 1986		Sep 1986		Oct 1986		Nov 1986		Dec 1986	
	PE	RW	PE	RW	PE	RW	PE	RW	PE	RW	PE	RW
1	2	1	3	2	0	1	2	1	2	1	5	1
2	3	1	3	4	1	1	2	1	2	2	3	1
3	2	1	2	1	2	1	4	2	3	2	2	1
4	4	2	2	2	2	1	0	1	3	1	3	1
5	2	2	2	1	8	2	1	3	3	1	2	2
6	2	17	2	1	6	2	1	2	3	2	2	2
7	2	2	2	2	3	2	2	1	3	2	3	2
8	4	4	4	2	2	1	2	1	3	4	2	2
9	3	1	2	2	2	2	2	1	1	1	1	1
10	4	4	3	3	3	1	2	2	5	1	3	3
11	5	2	3	2	3	2	4	1	2	2	2	2
12	4	3	3	2	4	1	2	1	2	3	3	2
13	1	2	2	2	5	3	1	1	6	2	8	2
14	1	2	1	2	3	1	2	1	6	1	4	2
15	4	2	2	3	2	1	2	1	2	1	4	1
16	3	1	5	1	2	1	1	2	3	1	8	1
17	2	1	4	1	2	1	2	1	2	2	4	3
18	2	1	5	1	4	1	3	1	3	10	2	1
19	3	2	2	3	2	2	4	2	2	3	3	2
20	1	1	2	1	2	2	5	2	2	2	2	1
21	1	1	2	2	3	2	4	2	3	1	2	1
22	2	9	2	1	3	2	3	3	3	2	2	2
23	6	2	2	2	2	1	3	3	2	1	2	2
24	2	3	2	2	3	5	2	1	1	1	3	2
25	4	1	1	2	3	2	1	3	2	1	3	2
26	4	4	2	1	2	1	2	2	3	1	3	2
27	2	2	2	1	2	2	1	2	3	3	2	3
28	1	2	2	1	1	1	3	3	2	1	3	1
29	2	1	1	1	1	1	2	1	2	2	2	1
30	3	1	2	0	1	1	1	1	3	2	2	2
31	2	1	0	1			2	1			3	2
Av	2.7	2.5	2.3	1.7	2.6	1.6	2.2	1.6	2.7	2.0	3.0	1.7

a. PE = Plant Effluent, the total output from HSAAP wastewater treatment facility; RW = River Water or Raw Water, plant intake water before treatment.

APPENDIX B

GLOSSARY OF TERMS

BOD	Biochemical oxygen demand
BOD_5	Five-day biochemical oxygen demand
BRDL	US Army Biomedical Research and Development Laboratory
COD	Chemical oxygen demand
HDC	Holston Defense Corporation
HSAAP	Holston Army Ammunition Plant
k_{BOD}	Specific rate of BOD utilization
RDX	Hexahydro-1,3,5-trinitro-1,3,5-triazine
S_o	Influent total BOD_5
S_e	Effluent soluble BOD_5
X_v	Volatile suspended solids

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